



Centro de Previsão de
Tempo e Estudos Climáticos

CPTEC / INPE

www.cptec.inpe.br

33rd WGNE Meeting, Tokyo, Japan
Oct 2018

Fixing systematic errors at CPTEC

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Thanks to P. Kubota, G. Pereira, D. Castilho, E. Ramirez, D. França, E. Vendrasco

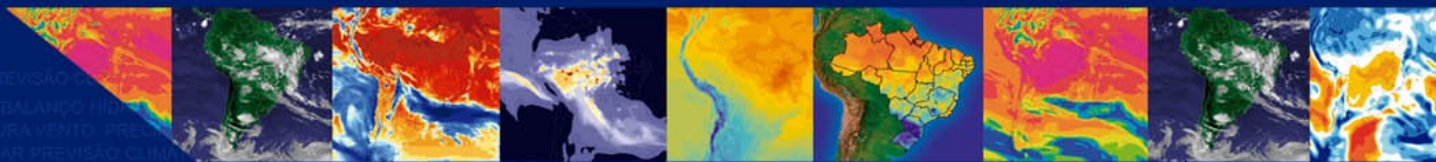
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October 2018

Ciência e
Tecnologia
a serviço
da sociedade



MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E INOVAÇÃO
INSTITUTO NACIONAL DE PESQUISAS ESPaciais



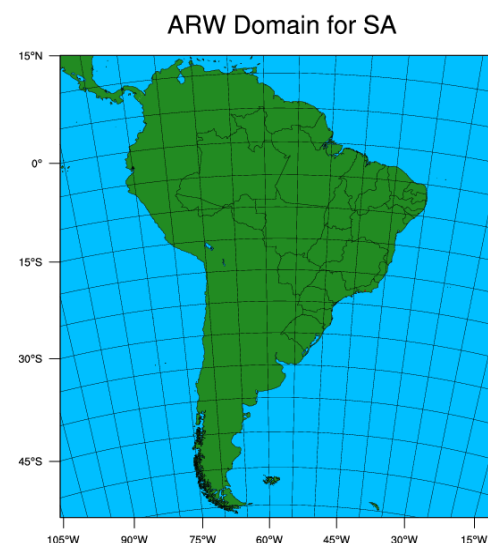
Outline

- Progress on regional modelling
- Progress on global modelling

New Operational Regional Model at CPTEC

- Model: WRF
- Dynamic Core: ARW
- Initial version: 3.9.1.1
- Resolution: 5km
- Levels: 42
- Vertical coordinate: Sigma
- Operational since June 1, 2018
- It runs twice a day (00 e 12Z)

Microphysics	Ferrier
PBL	YSU – Yonsei University
Surface	Noah
Surface Layer	Monin-Obukhov revised
Convection	New Tiedke
Radiation	RRTMG



BRAMS air quality (20km already in operation)

Improvements in the pre-processor tool

Improvements of 3BEM methodology – review of emission factors

FRP methodology (version 1.6)

Streets inventory for MARJ (version 1.5)

Improvement of urban emissions for MASP

Improvements in the model (only research)

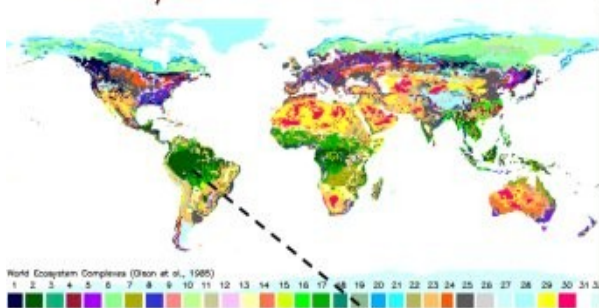
Implementation of Runge-Kutta time integration scheme (under tests)

Implementation of a new computational method on chemistry module

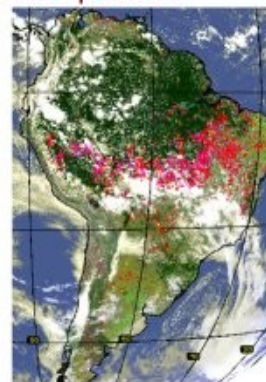
~70% more efficient

Biomass burning emissions inventory Brazilian Fire Emission Model: Regional scale - daily basis

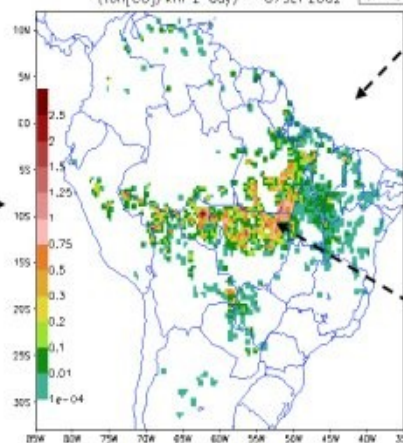
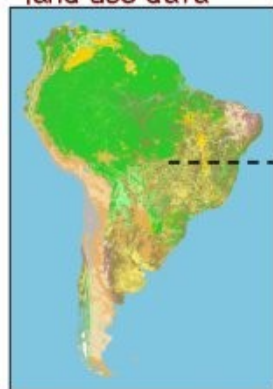
density of carbon data



near real time fire product



land use data



emission & combustion factors

Biome category	Emission Factor for CO (g/kg)	Emission Factor for PM2.5 (g/kg)	Aboveground biomass density (α, kg/m²)	Combustion factor (β, fraction)
Tropical forest ¹	110.	8.3	20.7	0.48
South America savanna ²	63.	4.4	0.9	0.78
Pasture ³	49.	2.1	0.7	1.00

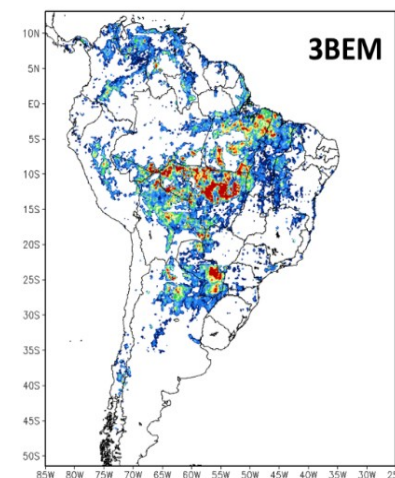
¹ Average values for primary and second-growth tropical forests. ² Average values for campo cerrado (C3) and cerrado sensu stricto (C4). ³ value for campo limpo (C1). All numbers are from Ward et al.,

mass estimation

$$M[\eta] = \alpha_{veg} \cdot \beta_{veg} \cdot E_{f_{veg}}^{[\eta]} \cdot a_{fire},$$

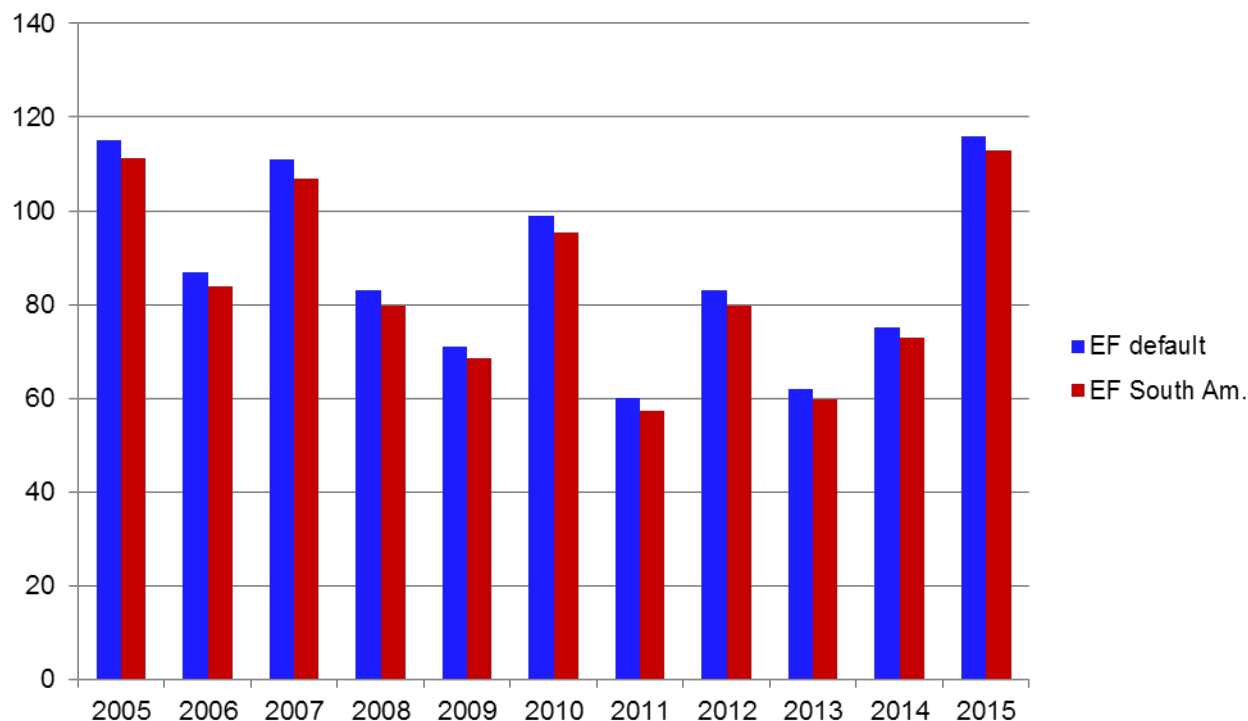
CO source emission (kg m⁻² day⁻¹)

3BEM



Emission factors updates

Annual Emissions of CO (Tg) from biomass burning in South America

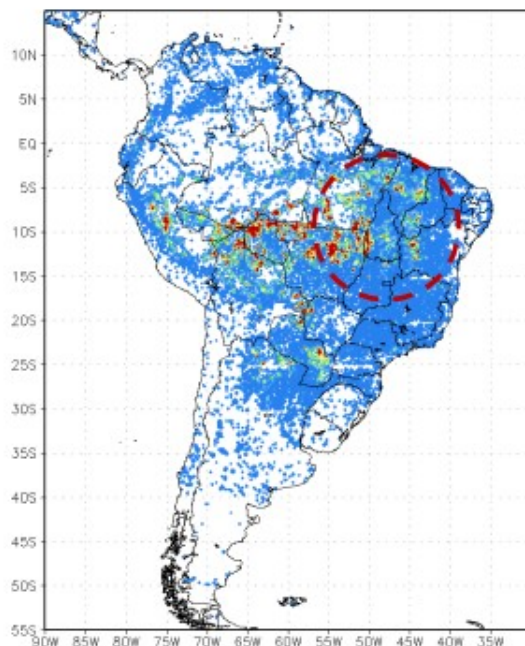


- Emission inventories with 20 km x 20 km spatial resolution;
- PREP using fire counts;
- EFs updates based on Andreae e Merlet (2001), Andreae (personal communication, 2016) and Yokelson et al. (2013).

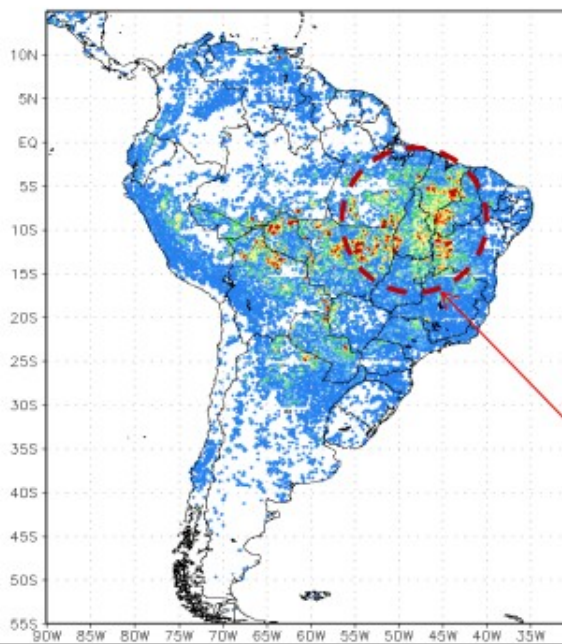
FRP implementation

Inventories evaluation CO (Kg/m²)

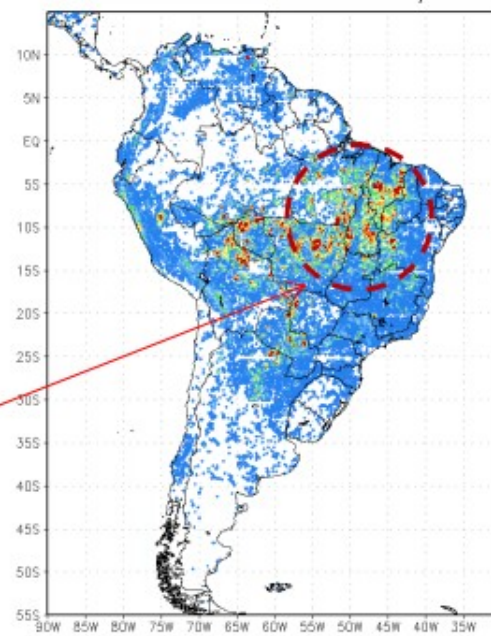
3BEM_Trad



FRP



FEER

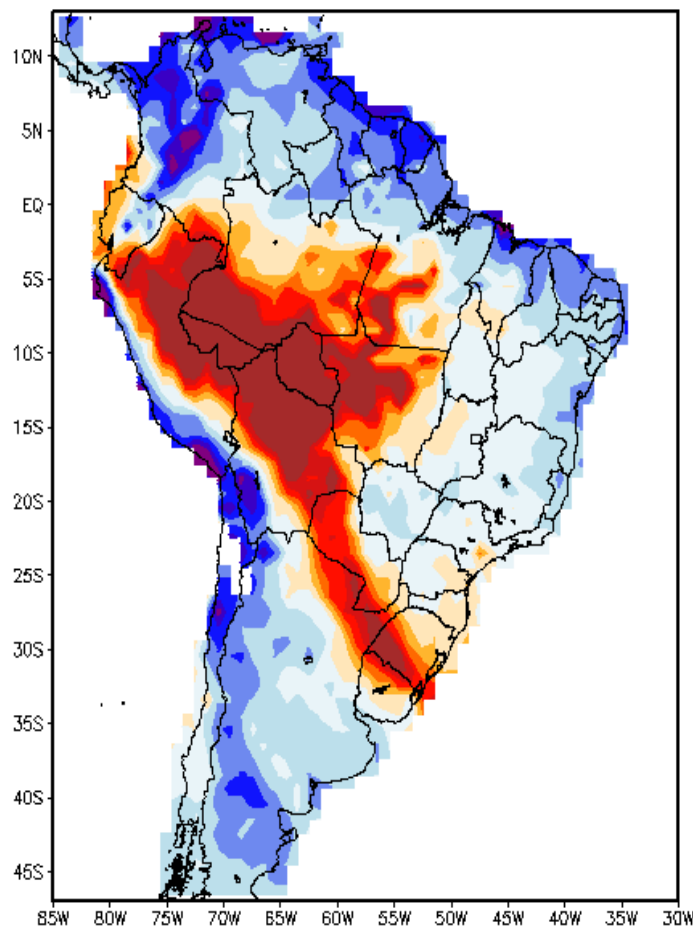


Courtesy: Gabriel Pereira

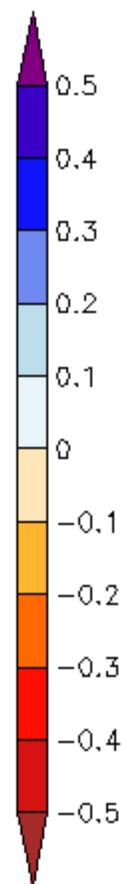
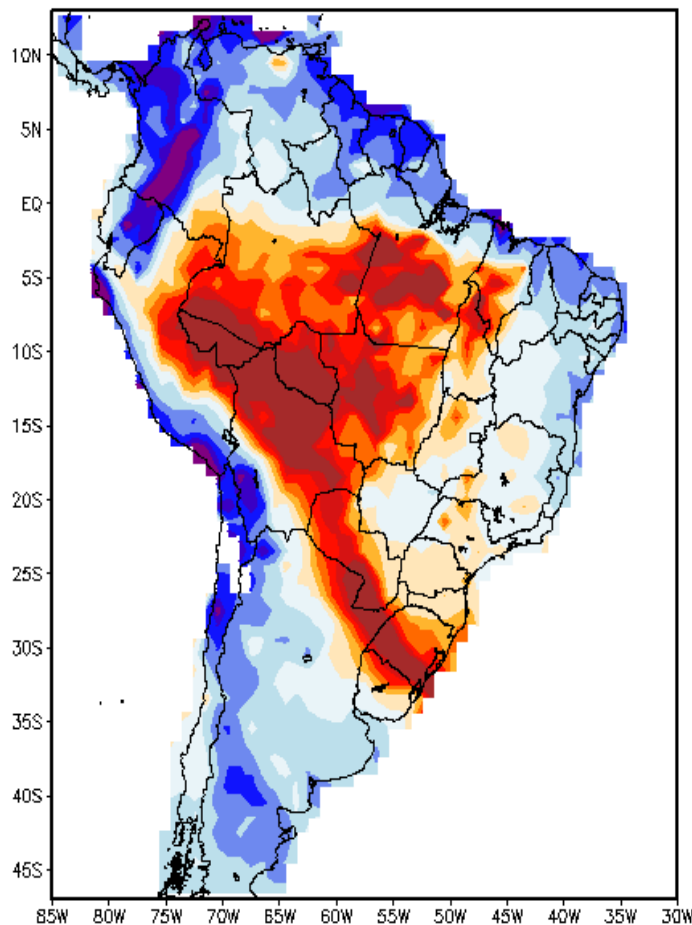
Fire Energetics and
Emissions Research
(FEER)

Towards the implementation of FRP at CPTEC/INPE

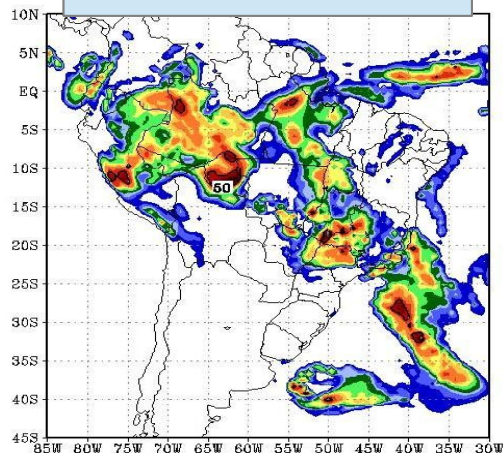
Difference aot550
MODIS-3BEM SEP 2014



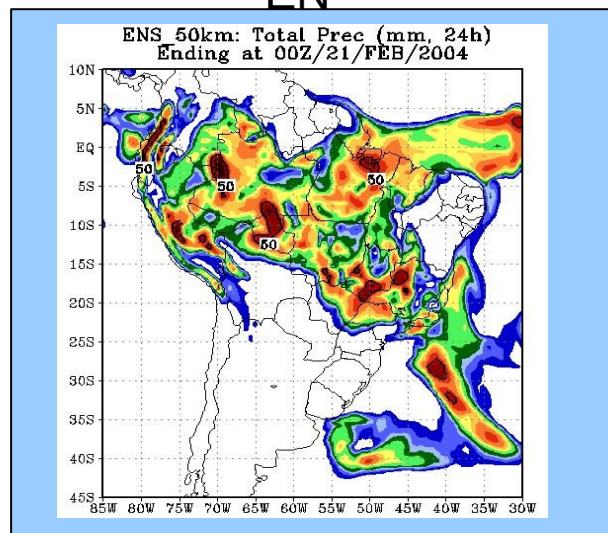
Difference aot550
MODIS-FRP SEP 2014



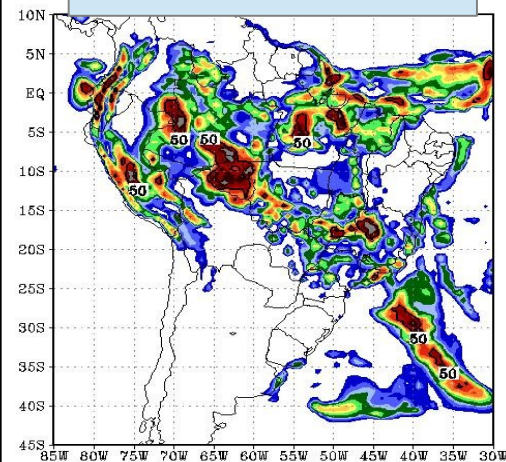
AS



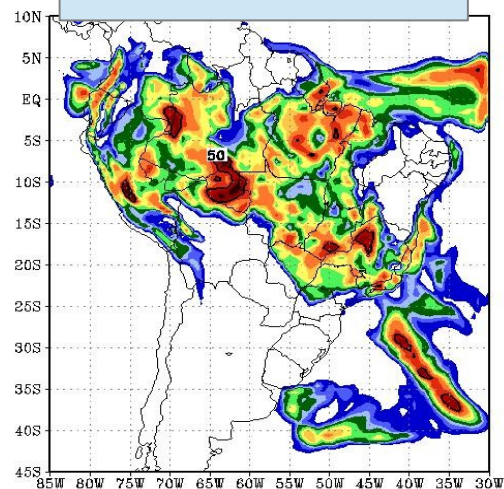
EN



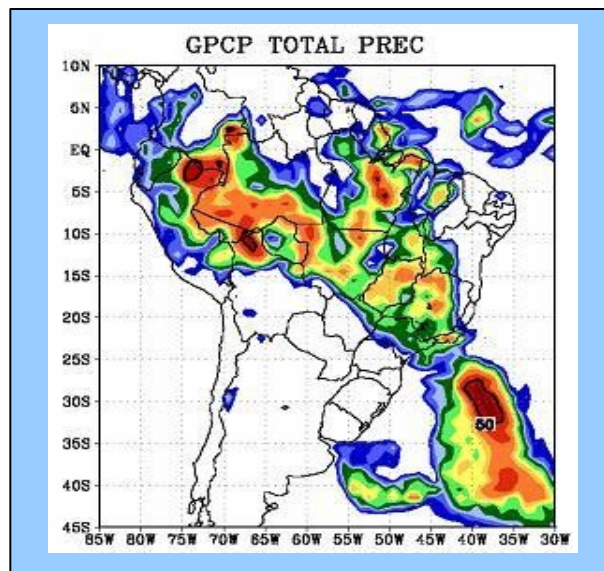
MC



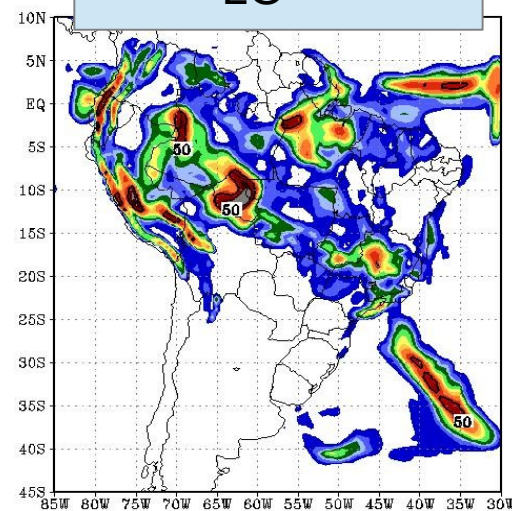
GR

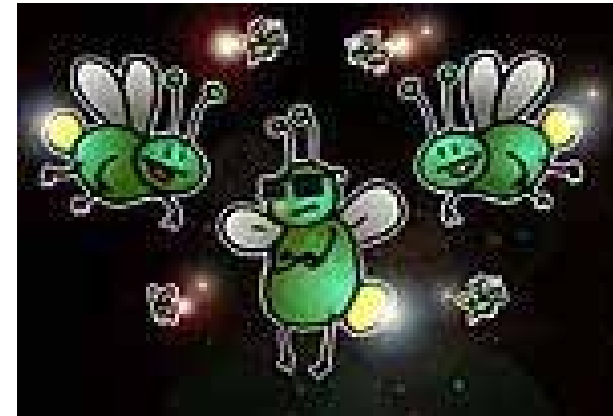


GPCP



LO





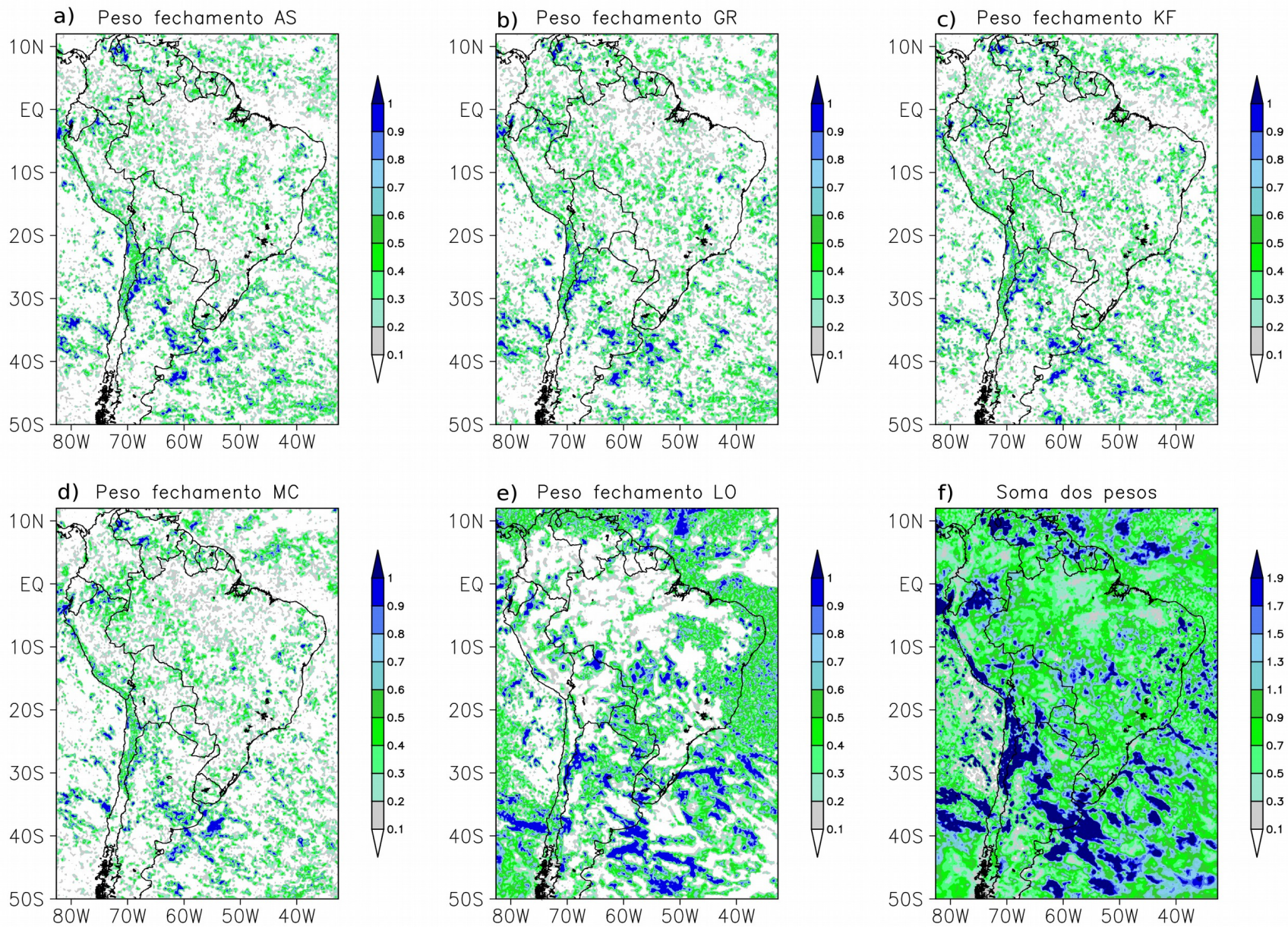
$$\min \left\{ P_M - P_O \right\}$$

model obs

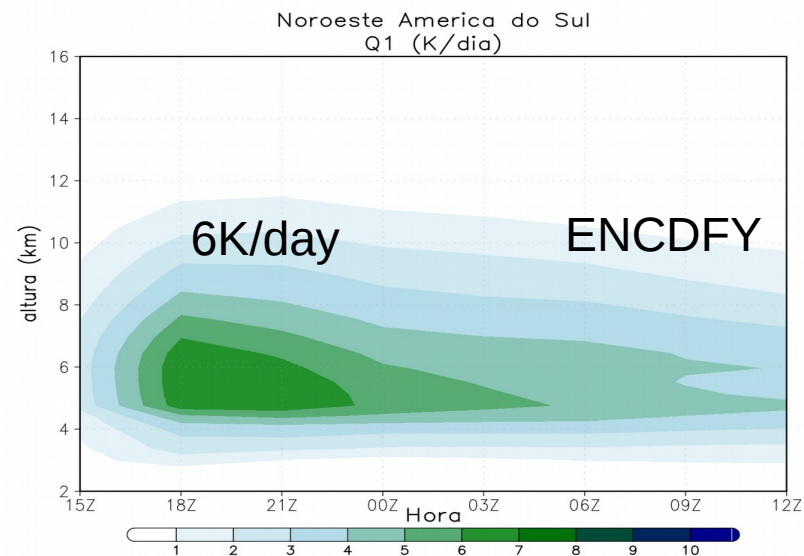
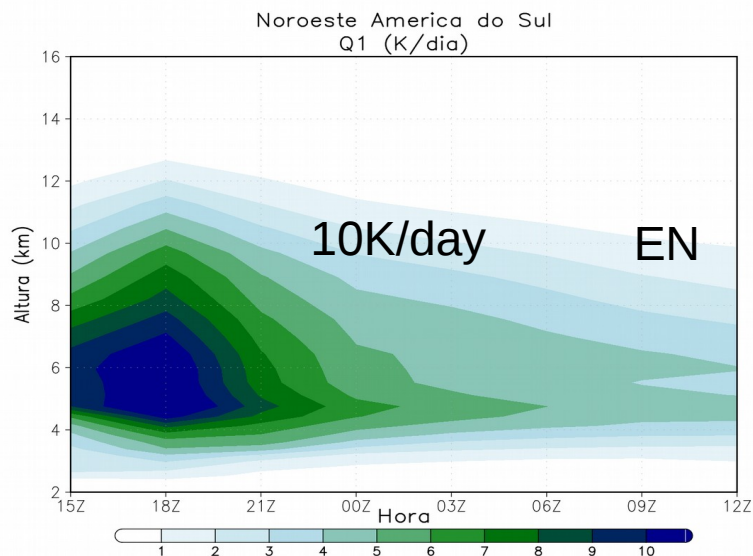
Inverse problem: parameter estimation***Inverse model***

$$\begin{aligned} J(\vec{P}) &= \min ||P_M(\vec{W}^T) - P_O||_2^2 \\ &= \sum_{i=1}^5 [P_M(w_i) - P_O]^2, \quad P_M = \sum_{i=1}^5 w_i P_i \end{aligned}$$

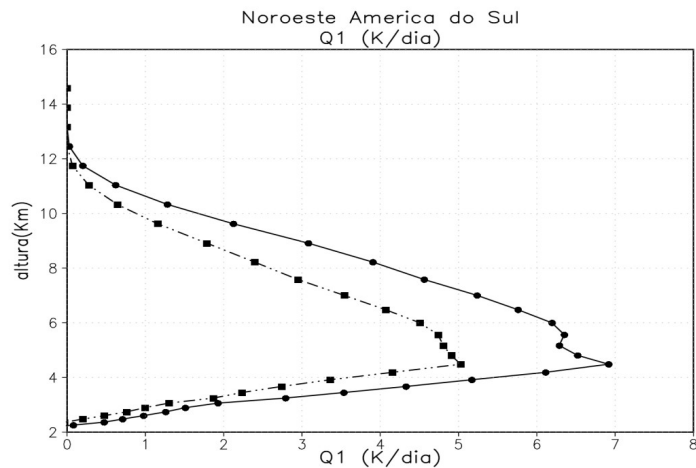
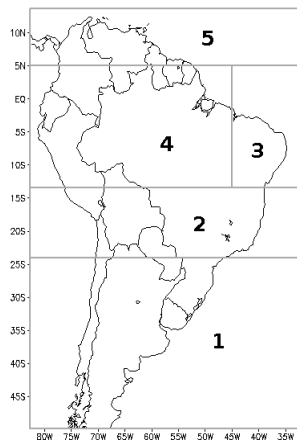
$$\vec{W}^T = [w_{GR}, w_{MC}, w_{LO}, w_{KF}, w_{AS}]$$



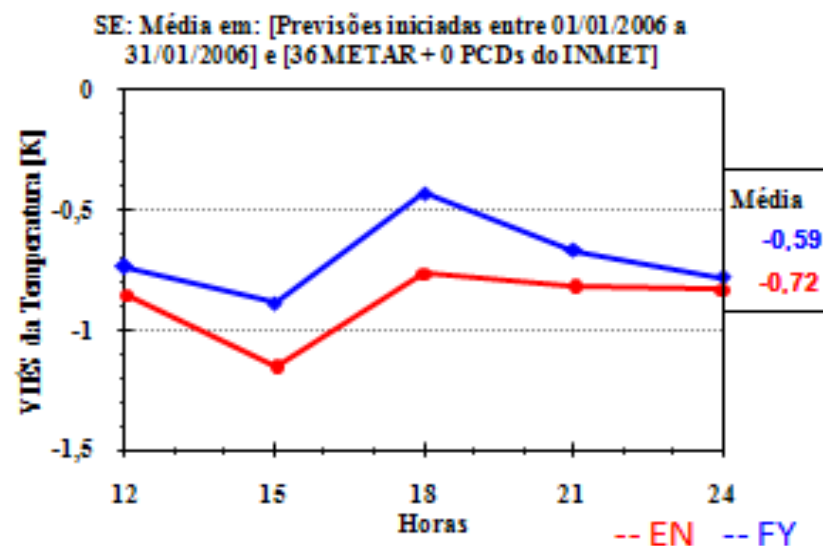
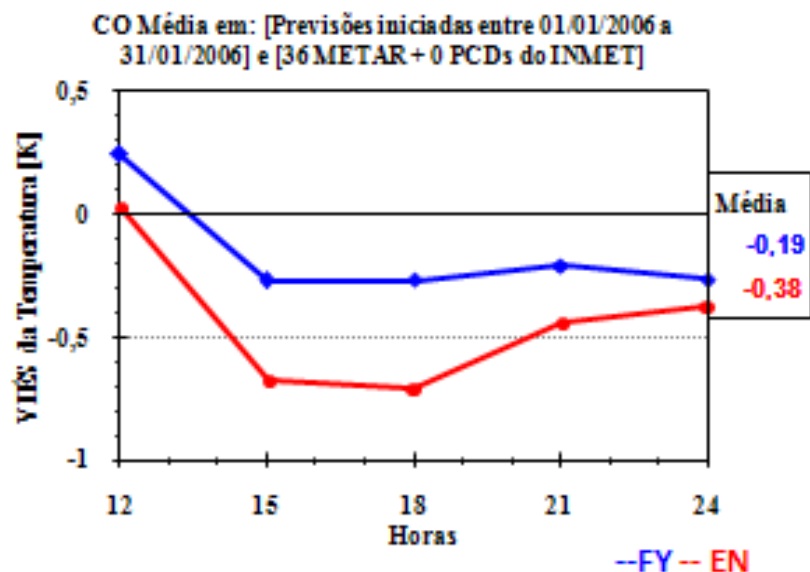
Heating rate (Q1) Northwest South America



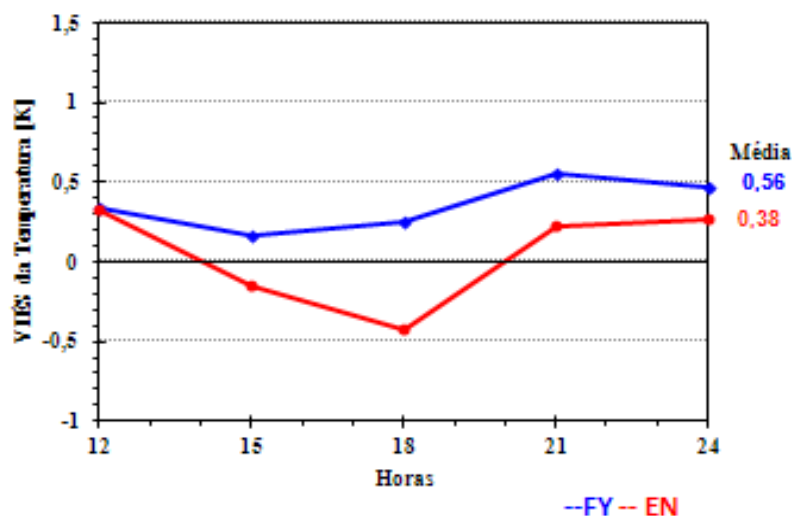
Mean



Bias 2-meter temperature



NO Média em: [Previsões iniciadas entre 01/01/2006 a 31/01/2006] e [43 METAR + 0 PCDs do INMET]



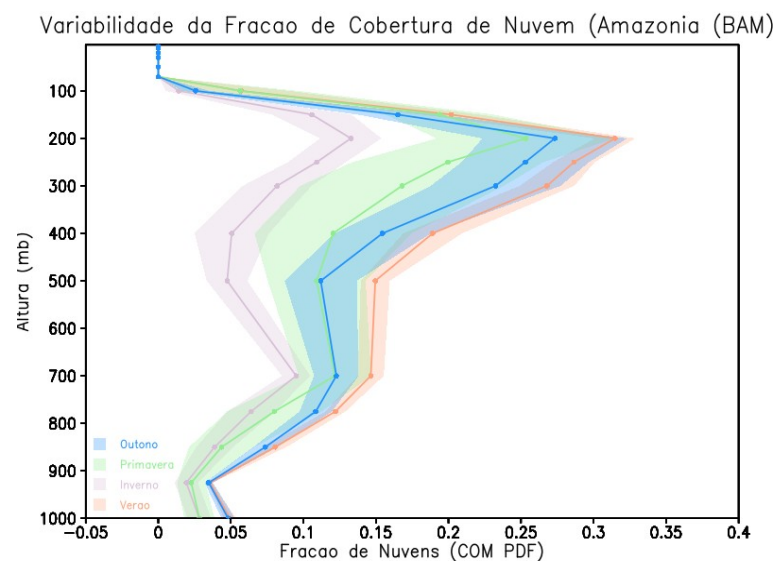
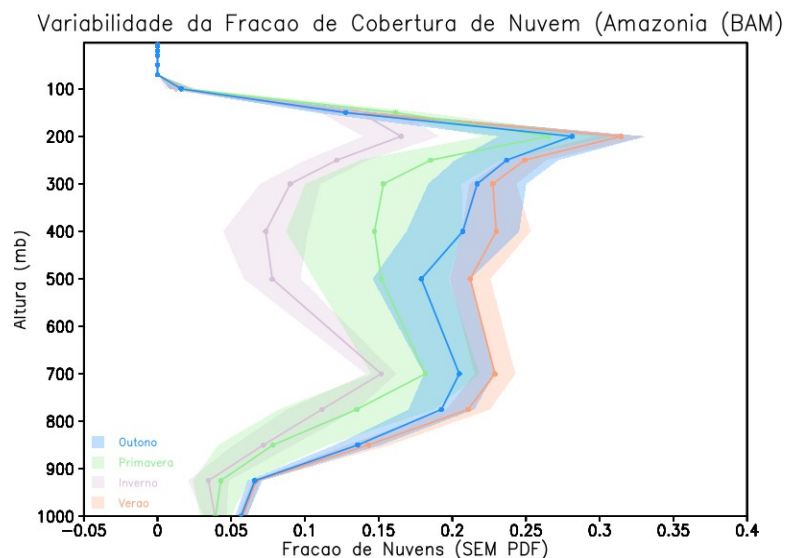
- FY
- EN

BAM - Global Model configuration

Figuerola et al., 2016

Dynamics	Spectral EU or SL semi-implicit model, with hydrostatic approximation, sigma vertical coordinate
Cloud microphysics	Double-moment microphysics scheme (Morrison et al. 2009)
SW and LW radiation <i>Implement. optical properties</i>	CLIRAD; Chou and Suarez (1999) and modified by Tarasova and Fomin (2000)
Deep convection <i>Improvements on the scheme</i>	Simplified version of Arakawa
Shallow convection	UW shallow convection (Park and Bretherton 2009)
Vertical diffusion	Modified Mellor and Yamada (1982) scheme
Land surface processes <i>New eq. to compute surface albedo</i> <i>Seasonal variability of LAI</i>	Dynamic vegetation model, IBIS

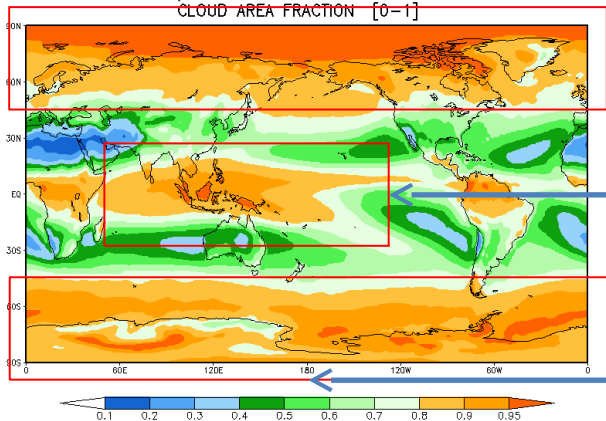
Implementation of a new cloud parameterization



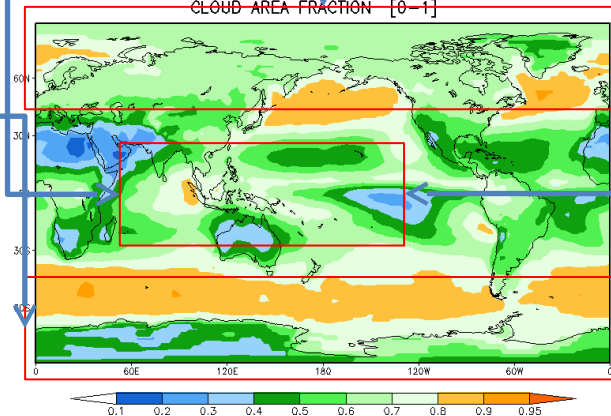
Without PDF(a) and with BAM PDF (1998-2008) cloud cover over Amazon for winter (purple), spring (green), fall (blue), summer (orange)

The Climate Science for Service Partnership Brazil

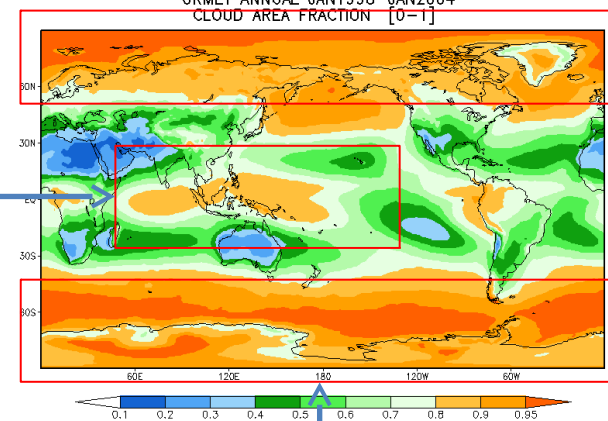
BAM TQ0126L042 ANNUAL JAN1998-JAN2004
CLOUD AREA FRACTION [0-1]



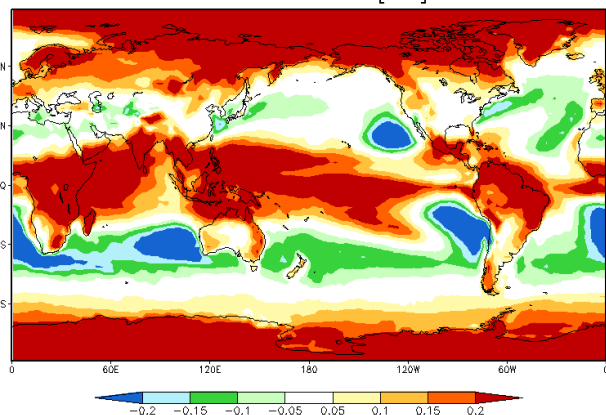
ISCCP ANNUAL JAN1998-JAN2004
CLOUD AREA FRACTION [0-1]



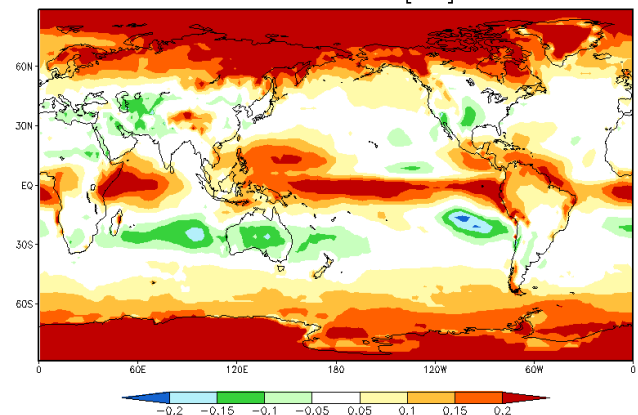
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CLOUD AREA FRACTION [0-1]



[BAM-ISCCP] ANNUAL JAN1998-JAN2004
CLOUD AREA FRACTION [0-1]



[UKMET-ISCCP] ANNUAL JAN1998-JAN2004
CLOUD AREA FRACTION [0-1]



Courtesy Dayana Castilho



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Thanks for your attention!